THE

VETERINARY JOURNAL

Editor :

PROFESSOR T. DALLING, M.A., M.R.C.V.S.,
Professor of Animal Pathology and Director of The Institute of Animal Pathology, Cambridge University

Sub-Editor :

PROFESSOR J. McCUNN, M.R.C.V.S., M.R.C.S., L.R.C.P.,
Professor of Anatomy, The Royal Veterinary College

APRIL, 1941.

Editorial

THE CONTROL OF DISEASES OF LIVESTOCK

An article in a daily newspaper concerning disease in livestock has been brought to our notice. It refers to " the apparent inability of the veterinary profession and those engaged in research work to combat, either by prevention or cure, most of the diseases which afflict farm stock." It is regrettable that in 1941 any member of the agricultural community should feel in the position to make such a statement. Not only will the research worker resent such a remark but his views will also be shared by the veterinary practitioner. There is no need at this late date to show in detail how our knowledge of diseases of livestock has improved during the past twenty years, nor how methods of control (curative and preventive) have been evolved and are now in everyday practice. It is true, of course, that we have still some distance to go before we can claim that our knowledge is near completion and that our methods of control can prevent entirely the occurrence and spread of disease; it must be admitted, however, that concerning many of the important diseases the practising of present-day methods of control is followed by results sufficiently satisfactory to make the keeping of livestock a more economic proposition.

In spite of our knowledge and the practising of methods of control based on scientific evidence and practical results, disease still abounds in many herds and flocks to a considerable extent. The reason for this is not far to seek when we realise that, in many instances, veterinary practitioners are only asked to treat certain types of cases often when it is too late to effect a cure

or to prevent the spread of an infection. There is still lacking in agriculture that close collaboration between the stockowner and his veterinary practitioner which is so desirable and necessary for the adequate control of disease. At a time like the present, when healthy animals are so important and the suppression of disease is so necessary, some means should be sought to bring into being such a collaboration. The end of all research work is the practical application of the result: to a considerable degree the results of research work on animal disease are in a state that they can be applied now. We look forward to the evolution of a plan whereby the veterinary profession, including the practitioner and research worker, will work hand in hand with the livestock owner in suppressing these diseases, often insidious in character, which lower the productiveness of our livestock and decrease their economic value. Further, it should be the aim of all concerned to-day to have in this country high grade, *healthy* livestock for immediate post-war requirements, for undoubtedly the demand will be great, not only in our own country, but in other countries where depletion of stock of all kinds is apparently in progress now.

TUBERCULOSIS IN CATTLE

Tuberculosis in cattle is always a subject of great practical economic interest and its control is always before us. The use of tuberculin in the diagnosis of bovine tuberculosis is relied on to a considerable extent in the suppression and control of the disease. Tuberculins of different types have been introduced from time to time, each new product believed to be an improvement on the former types. Veterinary surgeons are now acquainted with avian tuberculosis in cattle and are beginning to realise that it may exist in herds to a greater extent than was formerly thought. The result is that tuberculin testing is proving to be somewhat more complicated than may have been realised.

In this issue of THE VETERINARY JOURNAL we publish a paper concerning the results of the testing with various "tuberculins" of guinea-pigs sensitized with various acid-fast organisms. While it must be pointed out that the experiments are definitely of a preliminary nature and that the extracts of the organisms composing the "tuberculins" were not standardised, there is contained in the results some indication of cross-reaction. This all may have a bearing on tuberculin testing of cattle. We know that cattle infected with avian tuberculosis may react to mammalian tuberculin, that the vole strain in cattle causes marked reaction to mammalian tuberculin and that cattle infected with Johne's disease may react to avian tuberculin. This subject must be pursued further and research must be continued till a specific tuberculin is evolved or a method of testing is elaborated whereby specific results will be largely obtained.

General Articles

THE INTER-RELATIONSHIP BETWEEN THE ALLERGIC RESPONSES OF GUINEA-PIGS SENSITISED WITH VARIOUS MEMBERS OF THE ACID-FAST GROUP OF ORGANISMS

By L, SAHAI, M.Sc., M.R.C.V.S.

Institute of Animal Pathology, University of Cambridge.

In order to determine the inter-relationship between the allergic responses of guinea-pigs sensitised with various members of the acid-fast group of organisms, cultures of the following eight strains were inoculated into guinea-pigs :—

Tubercle bacillus (human type).
Tubercle bacillus (avian type).
Johne's bacillus.
A strain of acid-fast organism isolated from the vole.
M. phlei.
M. smegmatis.
M. butyricum.
M. stercoris.

Since antigenically, the human and bovine types of tubercle bacilli are very closely related, only the former was used.

The human and avian strains of tubercle bacilli had been isolated some time previously from a tuberculous human patient and a natural case of tuberculosis in a fowl respectively, and had conformed in their cultural characters to standard human and avian strains. The Johne's strain, No. 2, was obtained from the Ministry of Agriculture's Veterinary Laboratory, Weybridge. The vole strain was LV.285, obtained from Dr. A. S. Griffith, while M. butyricum, M. smegmatis 523 and M. stercoris 3820 were obtained from the Lister Institute. The strain of M. phlei had been used for a long time in this laboratory in the preparation of media for the cultivation of Johne's bacilli.

Each of these strains was inoculated into 12 guinea-pigs. With the human and avian strains of tubercle bacilli, a saline suspension of a culture about a month old was inoculated subcutaneously, each guinea-pig receiving 0.5 mgm. The other cultures, 4-6 weeks old, were inoculated in the form of liquid para-

XUM

Guinea-pigs sensitised with the human tubercle bacillus, tested after 35 days.
Test materials and dilutions.

G.P. No.	Mammalian tuberculin			Avian tuberculin				Johnin				Vole strain extract			M.phlei extract				M.butyricum extract				M.smegmatis extract				M.stercoris extract			
	1/500	1/1000	1/2000	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200
1	++ 10	++ 10	+ 8	+++ 16	++ 10	+ 4	-	+ 7	+ 7	-	-	+++ 20	+ 5	-																
2	++ 8	++ 8	+ 4	++ 6	+ 3	-	-	++ 9	+ 4	-	-	+++ 12	+ 4	-																
5	++ 12	+ 6	-												+ 6	+ 5	-	-	+++ 15	-	-	-					± 3	± 3	-	-
6	+++ 12	++ 7	+ 6												++ 16	++ 10	+ 6	+ 5	+++ 20	++ 8	+ 5	+ 5					+++ 15	+ 5	+ 5	-

Guinea-pigs 3, 4 and 7 to 12 died soon after the test injections and the reactions were not read.

Guinea-pigs sensitised with the Avian tubercle bacillus, tested after 37 days.
Test materials and dilutions.

G.P. No.	Avian tuberculin			Mammalian tuberculin				Johnin				Vole strain extract			M.phlei extract				M.butyricum extract				M.smegmatis extract				M. stercoris extract			
	1/500	1/1000	1/2000	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200
1	++ 8	+ 5	+ 4	+++ 15	+ 5	+ 5	-	+++ 12	++ 8	+ 5	-	++ 10	-	-																
2	+ 5	+ 4	±	+ 8	-	-	-	+++ 15	++ 8	+ 4	-	++ 8	+ 4	-																
3	++ 8	+ 5	+ 5	++ 10	+ 4	-	-	+++ 15	++ 7	+ 5	-	+ 5	-	-																
4	++ 6	++ 6	+ 3	+++ 15	++ 6	+ 4	-	+++ 15	++ 7	+ 4	-	+ 5	-	-																
5	+ 4	+ 4	-												++ 7	+ 4	-	-					+++ 10	+ 4	-	-				
6	+ 5	+ 5	-												+ 4	-	-	-					++ 8	-	-	-				
7	++ 7	+ 5	+ 3												++ 10	+ 4	+ 4	-					+++ 12	++ 7	++ 7	+ 3				
8x																														
9	-	-	-																-	-	-	-					-	-	-	-
10	+ 4	+ 4	-																-	-	-	-					+ 3	-	-	-
11	+++ 10	++ 7	++ 5																++ 10	++ 10	+ 4	+ 4					++ 8	+ 4	-	-
12	++ 7	++ 7	+ 5																++ 7	-	-	-					++ 10	+ 4	-	-

x Died following the test injection.

ffin emulsions intramuscularly in the thigh, following the technique described by Hagan and Levine (1932). The dose of each strain was 2-3 mgms.

With a view to obtaining a very high degree of sensitisation, it was at first proposed to inject the liquid paraffin emulsions intraperitoneally, but as Hagan and Levine report that guinea-pigs so treated often die, and the number of guinea-pigs at one's disposal was small, this method was not adopted. Nevertheless, as will be seen later, quite a high degree of sensitisation was obtained following the intramuscular route.

Only white guinea-pigs were used, with an average weight of about 500 grms. It is very important that for this work only large, healthy guinea-pigs be used, as small animals do not react well and very often succumb following the injections.

Following the intramuscular injection of liquid paraffin emulsions of the non-pathogenic strains, an abscess formed at the seat of inoculation, which burst, discharging yellowish caseo-purulent contents. On post-mortem examination the guinea-pigs revealed enlargement of the associated inguinal and sublumbar glands. A few small translucent foci were present in the lungs. These were larger after M. phlei inoculation and occurred with much greater frequency. The lesions following inoculation of M. phlei were, on the whole, more severe than those following inoculation of other non-pathogenic bacilli. There was often definite caseation of the inguinal glands and sometimes even of the sublumbar.

For testing the guinea-pigs, mammalian tuberculin prepared from human strains and avian tuberculin were obtained from the Ministry of Agriculture's Veterinary Laboratory, Weybridge. Johnin was also obtained from Weybridge. The other extracts were prepared by the author. For this purpose, cultures of the different strains, except the vole, were grown on five per cent. glycerine broth for 4-6 weeks. They were then steamed for three hours, the bacillary bodies removed by filtration through a filter paper, and the filtrate concentrated to 1/10th of its original volume over a water bath.

Several attempts were made to grow the vole bacillus on glycerine broth, but without success. As the time for testing was approaching, it was decided to make a glycerine extract of such growth as was available on tubes in stock culture. The growth obtained in this way, however, proved to be only 340 mgs.; it was extracted with 10 c.c. of a 40 per cent. solution of glycerine for two hours at 100 degrees C. The extract prepared in this way was naturally weak, but it evoked quite good reactions in guinea-pigs sensitised with the vole strain.

The guinea-pigs were tested after intervals varying from 35 to 52 days following injection. The exact intervals are given in the appropriate tables.

The hair was removed from the flanks of the animals by means of a depilating powder so that a perfectly smooth and clean surface was obtained.

Guinea-pigs sensitised with Johne's bacilli, tested after 43 days.
Test materials and dilutions.

G.P. No.	Johnin 1/50	1/500	1/1000	1/2000	Mammalian tuberculin 1/5	1/25	1/100	1/200	Avian tuberculin 1/50	1/500	1/1000	1/2000	Vole St. extract 1/5	1/25	1/100	M.phlei extract 1/5	1/25	1/100	1/200	M.butyricum extract 1/5	1/25	1/100	1/200	M.smegmatis extract 1/5	1/25	1/100	1/200	M. stercoris extract 1/5	1/25	1/100	1/200
1	+++ 12 *	++ 8	++ 8	+ 4	++++ 20x15	+++ 14	++ 8	+ 5	++++ 14 *	++ 7	++ 6	+ 4	+++ 15	++ 8	+ 6																
2	+++ 12	++ 6	++ 6	+ 3	++++ 15	++ 8	+ 4	+ 3	+++ 12	++ 6	++ 6	+ 3	+ 5	+ 5	+ 4																
3	+++ 15	++ 6	+ 3	+ 3	++++ 22 *	+++ 10	++ 8	+ 5	+++ 12	++ 5	+ 3	+ 3	++ 8 ††	+ 6	+ 4																
4	+++ 14	++ 9	++ 8	+ 3	+++ 14	++ 6	++ 6	+ 3	+++ 14	++ 8	+ 7	+ 5	++ 8	+ 6	+ 4																
5	++ 10	+ 4	+ 3	-												++ 10	-	-	-					+++ 19 ††	++ 8	-	-				
6	+++ 12	++ 6	++ 6	+ 4												+++ 10	++ 7	+ 3	-					+++ 10	++ 6	+ 4	-				
7	++ 7	+ 5	+ 5	-												++ 8	-	-	-					++ 10	+ 4	+ 4	-				
8	+++ 10	+ 5	+ 5	-												++ 10 n	+ 4	+ 4	-					++ 11 n	+ 4	-	-				
9	+++ 13	++ 7	+ 5	+ 5																+++ 13 *	++ 7	+ 3	-					++ 12 *	+ 5	+ 4	-
10	+++ 12	++ 9	+ 6	+ 5																+++ 15 *	++ 12	++ 6	-					++++ 16	++ 10	++ 8	+
11	+++ 12	+ 5	+ 5	+ 5																++++ 20 *	++ 12	+ 5	-					++ 12	+ 6	+ 5	-
12	+++ 12	++ 8	+ 4	-																++++ 20 *	++ 12	+ 6	-					Due to excoriation of skin could not be read.			

* Blanched centre. † Hæmorrhagic. †† Diffuse redness. n Slight necrosis.

Guinea-pigs sensitised with the Vole Strain of acid-fast bacillus, tested after 42 days.
Test materials and dilutions.

G.P No.	Vole Strain extract 1/25	1/100	1/200	1/500	Mammalian tuberculin 1/5	1/25	1/100	1/200	Avian tuberculin 1/5	1/25	1/100	1/200	Johnin 1/5	1/25	1/100	1/200	M.phlei extract 1/5	1/25	1/100	1/200	M.butyricum extract 1/5	1/25	1/100	1/200	M.smegmatis extract 1/5	1/25	1/100	1/200	M.stercoris extract 1/5	1/25	1/100	1/200
1	++ 10	+ 8	+ 6	+ 6	+++++ 24x20	++++ 20x8	+++ 10	++ 8	+ 8	-	+ 8	-	+ 10	-	-	-																
2	+++ 12	-	-	-	+++++ large bulky	++++ 15x10	++ 8	++ 8	++ 12	+ 7	+ 5	-	± 4	± 4	-	-																
3	+++ 12	++ 8	++ 8	-	+++++ 25 *	++++ 17	+++ 14	++ 8	++ 12x7	++ 7	++ 6	-	+++ 12	-	-	-																
4	+++ 10	++ 5	+ 3	+ 3	+++++ 22	++++ 15x20	+++ 13	++ 9	++ 8	± 3	+ 5	-	+ 8	-	-	-																
5	++ 15	++ 10	++ 10	+ 5													++ 10	+ 5	-	-					+++ 20	++ 15	++ 10	+ 5				
6	+++ 15	+++ 15	++ 10	++ 10													++ 12	+ 3	-	-					+++ 20	+ 6	+ 5	-				
7	+++ 15	++ 12	++ 12	+ 8													+ 6	-	-	-					++ 12	-	-	-				
8	++ 12	-	-	-													+ 4	-	-	-					++ 8	++ 8	-	-				
9	++++ 20x7	+++ 10	+++ 12	++ 8																	± 3	± 3	± 3	-					+ 5	+ 4	-	-
10	++++ 16	+++ 15	+++ 12	+++ 11																	++ 10	+ 3	+ 3	-					+ 8	+ 8	-	-
11	+++ 20	+++ 15	++ 10	+ 8																	+ 6	+ 6	-	-					++ 10	+ 6	-	-
12	+++ 15	++ 10	++ 10	+ 4																	-	-	-	-					+ 5	-	-	-

Each guinea-pig was tested with an extract of the organism with which it had been sensitised, usually in a high dilution, to serve as a check on its sensitivity, and with two or three of the other extracts in low dilutions. Each extract was tested on four guinea-pigs. It may be remarked, however, that as one guinea-pig in each of the groups—M. phlei and M. stercoris, died of an unknown cause prior to testing, the number of guinea-pigs actually available for tests in these groups was eleven. Moreover, eight guinea-pigs died following the test injections in the human tubercle bacillus group, and one in the avian group, so that the number of animals remaining for readings was only four in the former and eleven in the latter group.

Dilutions of the extracts were prepared with normal saline immediately before they were injected intradermally into the guinea-pigs. A separate syringe was used for each extract, and the higher dilutions were injected first. The dose of each dilution was 0.2 c.c.

Readings were made at the 24th hour and again at the 48th hour, though by this time the reactions, especially those to heterologous extracts, had begun to fade. The reaction to an homologous extract takes the form of a red, raised plaque with blanching, necrosis or hæmorrhage in the centre, depending upon the severity of the reaction, and persists for several days. Reactions to heterologous extracts, when they are severe, also take this form, but very often they show as diffuse erythematous areas, and may fade or completely disappear by the 48th hour.

Reactions to homologous extracts sometimes continue to increase in intensity up to the 48th hour, and swellings, which were rather pale and indefinite at first become redder and more sharply defined at the 48th hour. Hæmorrhage and necrosis are also best assessed at the 48th hour.

The reactions were measured in m.m. and their characters noted. Depending upon these criteria, an approximate value in pluses (+) was assigned to each reaction. In the tables which follow, the reactions as assessed in pluses, together with figures to indicate their measurements in m.m., as well as other details, are given.

As a check on their specificity, each of the extracts was tested on four normal guinea-pigs, but except for a slight reddening around the site of the needle puncture following the injection of the saprophytic extracts (diluted 1 in 5), no changes which could be called reactions were observed. This slight reddening was not of the order which has been assessed as a + reaction in the tables.

The reactions of the different groups are given in the appended tables, but attention may be invited to the more salient features of each group.

Human Tubercle Bacillus

The guinea-pigs were tested after 35 days, but eight died during the night following the test injections.

Guinea-pigs sensitised with M. phlei, tested after 46 days.
Test materials and dilutions.

G.P. No.	M.phlei extract 1/50	1/500	1/1000	1/2000	Mammalian tuberculin 1/5	1/25	1/100	1/200	Avian tuberculin 1/5	1/25	1/100	1/200	Johnin 1/5	1/25	1/100	1/200	Vole St. extract 1/5	1/25	1/100	M.butyricum extract 1/5	1/25	1/100	1/200	M.smegmatis extract 1/5	1/25	1/100	1/200	M.stercoris extract 1/5	1/25	1/100	1/200
1	++++ 18	+++ 14	+++ 12	++ 8	+++ 12	++ 8	-	-	++ 9	+ 8	+ 8	+ 3	++ 6	-	-	-															
2	+++ 16	++ 10	+ 7	+ 5	+++ 15	++ 8	+ 5	-	++ 8	+ 5	+ 4	-	++ 7	+ 4	+ 3	-															
3	++++ 14	++ 10	++ 9	+ 6	++ 7	+ 4	+ 3	-	++ 8	-	-	-	+ 7	-	-	-															
4	++++ 19	+++ 15	++ 15	++ 8	+++ 18	+	-	-	++ 6	+ 4	-	-	+ 4	-	-	-															
5	+++ 15	++ 8	+ 5	-																++ 8	+ 5	-	-	+++ 14	++ 7	+ 4	-				
6	++++ 16	++ 8	+ 6	+ 6																++ 10	++ 7	+ 6	-	++ 15	++ 6	+ 5	+ 5				
7	++++ 20	++ 8	+ 6	+ 5																+++ 20	-	-	-	+++ 20	+ 3	-	-				
8	++++ 20	++ 9	+ 8	+ 6																+++ 20	-	-	-	+++ 20	++ 8	+ 5	+ 5				
9	+++ 18	++ 12	++ 10	+ 6													-	-	-									-	-	-	-
10	++++ 16x20	+++ 12	+ 8	++ 10													+ ±	+ ±										+++ 16	++ 10	+ 7	- 7
11	+++ 13	++ 9	++ 8	+ 6													-	-	-									+ 5	+ 4	-	-

Guinea-pigs sensitised with M. butyricum, tested after 51 days.
Test materials and dilutions.

G.P No.	M.butyricum extract 1/500	1/1000	1/2000	1/4000	Mammalian tuberculin 1/5	1/25	1/100	1/200	Avian tuberculin 1/5	1/25	1/100	1/200	Johnin 1/5	1/25	1/100	1/200	Vole St. extract 1/5	1/25	1/100	M.phlei extract 1/5	1/25	1/100	1/200	M.smegmatis extract 1/5	1/25	1/100	1/200	M.stercoris extract 1/5	1/25	1/100	1/200
1	++++ 22	+++ 18	++ 17	++ 14	++++ 20	++ 12	-	-	+ 8	-	-	-	++ 6	+ 3	-	-															
2	++++ 18	+++ 18	++ 10	++ 14	++++ 25	+	-	-	++ 8	+ 4	-	-	+ 6	+	-	-															
3	+++ 15	+++ 15	++ 12	++ 12	++++ 17	+ 5	-	-	++ 8	+ 5	-	-	++ 7	+ 5	-	-															
4	+++ 16	+++ 16	++ 15	++ 10	++++ 18	+++ 14	-	-	+ 5	-	-	-	-	-	-	-															
5	+++ 19	++ 10	++ 8	++ 8													±	-	-	++++ 20	++ 12	-	-								
6	+++ 15	+++ 14	++ 10	+ 6													-	-	-	+++++ 20	+++ 17	+++ 14	++ 12								
7	++ 10	++ 8	++ 7	+ 6													-	-	-	++++ 20	+++ 12	++ 10	-								
8	+++ 17	++ 8	+ 8	+ 5													-	-	-	++++ 22	+++ 12	++ 8	+ 5								
9	+++ 15	+++ 14	++ 10	++ 8																				+++++ 25	+++ 15	++ 10	+ 5	++++ 18	++ 8	+ 5	+
10	+++ 15	+++ 13	++ 10	+ 5																				++++ 20	+++ 15	+ 5	-	++++ 17	+++ 15	-	-
11	+++ 17	+++ 15	+++ 15	++ 8																				+++++ 25	+++ 15	+ 8	-	++++ 20	+ 7	-	-
12	+++ 15	+++ 15	++ 12	++ 8																				+++++ 28	+++ 16	++ 8	- 5	++++ 17	+++ 12	+ 4	+ 4

The remaining guinea-pigs reacted well to mammalian tuberculin in dilutions of up to 1 : 2,000, and to low dilutions of the other extracts. Reactions to M. smegmatis extract were not determined, as all the four guinea-pigs tested with this extract died. But judging from the reactions of other groups, it would appear that they would also have reacted to this extract.

A noteworthy point is that such sensitised guinea-pigs react quite definitely to the vole strain extract.

Avian Tubercle Bacillus

One of the guinea-pigs, which were tested after 37 days, died during the night following the injections.

The others reacted well to avian tuberculin, sometimes in dilutions of up to 1 : 2,000, but to the other extracts they reacted in low dilutions only.

Vole Strain of Acid-fast Organism

The guinea-pigs were tested after 42 days. Since the homologous extract was presumed to be a weak one, dilutions up to 1 : 500 only were used, but judging from the reactions obtained, it appears that the sensitivity of these guinea-pigs was of an order in no way inferior to that of the other groups.

The guinea-pigs reacted strongly to mammalian tuberculin, giving a well-marked reaction even to a dilution of 1 : 200. The end point was not determined, but it may be presumed that it was in the neighbourhood of 1 : 500 or 1 : 1,000.

Reactions were obtained to low dilutions only of the other extracts.

Johne's Bacillus

The guinea-pigs were tested after 43 days and, as will be seen, reacted equally well to johnin and avian tuberculin even in a dilution of 1 :2,000.

To other extracts they reacted quite well, sometimes even in dilutions of 1 : 200.

M. Phlei

The guinea-pigs which were tested after 46 days reacted strongly to the homologous extract, even in a dilution of 1 : 2,000, and to lower dilutions only of the heterologous extracts. The reaction to the vole extract was doubtful.

M. Stercoris

These guinea-pigs, which were tested after 49 days, reacted very strongly to the homologous extract, even in a dilution of 1 : 4,000, and judging from the degree of reaction to this dilution, it would appear that the end point was much higher.

They did not react to the vole strain extract, and reacted to low dilutions only of the other extracts; to M. butyricum, M. phlei and M. smegmatis extracts slightly better than to others.

Guinea-pigs sensitised with M. smegmatis, tested after 52 days.
Test materials and dilutions.

	M.smegmatis extract				Mammalian tuberculin				Avian tuberculin				Johnin				Vole St. extract			M.phlei extract				M.butyricum extract				M.stercoris extract			
GP No.	1/500	1/1000	1/2000	1/4000	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200
1	+++ 15	+++ 12	+++ 8	++ 7	++ 9	+ 4	-	-	± -	-	-	-	+ 4	-	-	-															
2	+++ 13	+++ 13	+++ 12	++ 10	+++ 10	++ 8	+ 7	-	+++ 12	++ 8	+ 5	-	++ 9	+ 6	- -	-															
3	++++ 15 N.	++++ 14 N.	+++ 8 N.	++ 8	+++ 15	+ 6	-	-	++ 10	+ 4	-	-	++ 10	+ 5	-	-															
4	++++ 16 N.	++++ 16 N.	+++ 14	+++ 13	++ 12	+ 7	-	-	++ 10	+ 3	-	-	++ 7	+ 3	-	-															
5	+++ 16	+++ 16	++ 12	+ 5													-	-	-	+++ 14	+ 5	-	-								
6	+++ 13	+++ 13	++ 6	+ 5													-	-	-	+++ 15	++ 7	++ 7	-								
7	+++ 16	+++ 16	+++ 14	++ 10													-	-	-	+++ 15	-	-	-								
8	+++ 15	+++ 15	+++ 13	++ 7													-	-	-	+++ 14	++ 8	++ 7	-								
9	++ 7	+ 5	-	-																				-	-	-	-	++++ 23	++ 14	++ 14	+ 5
10	+++ 15	++ 12	++ 7	+ 8																				+++ 17	+ 5	+ 3	-	++++ 20	+++ 16	+++ 15	+ 8
11	++ 10	+ 5	-	-																				-	-	-	-	+++ 17	++ 5	+ 5	+ 3
12	++ 8	++ 8	+ 5	-																				++	+	-	-	++++ 20	+++ 16	++ 11	+ 5

Guinea-pigs sensitised with M. stercoris, tested after 49 days.
Test materials and dilutions.

	M.stercoris extract				Mammalian tuberculin				Avian tuberculin				Johnin				Vole St. extract			M.butyricum extract				M.smegmatis extract				M.phlei extract			
G.P. No.	1/500	1/1000	1/2000	1/4000	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200	1/5	1/25	1/100	1/200
1	+++ 12	+++ 14	++ 7	++ 6	+++ 14	+ 3	-	-	++ 7	+ 3	-	-	+ 3	-	-	-															
2	+++ 12	+++ 12	+++ 10	++ 8	++ 10	+ 3	-	-	++ 8	+ 3	-	-	± ±	-	-	-															
3	+++ 13	+++ 13	++ 6	++ 7	+ 7	-	-	-	+ 7	-	-	-	-	-	-	-															
4	+++ 15	+++ 13	++ 11	+ 6	+++ 14	+ 3	-	-	++ 10	+ 6	-	-	+ 7	±	-	-															
5	+++ 13	+++ 14	++ 7	+ 7													-	-	-									-	-	-	-
6	+++ 12	+++ 11	++ 9	++ 9													-	-	-									++++ A 15	+++ 12	++ 6	+ 5
7	+++ 14	+++ 14	++ 8	++ 6													-	-	-									+++ ++ 30	++ 7	+ 3	-
8	+++ 14	+++ 12	++ 10	++ 10													-	-	-									++++ +n 16	++ 9	++ 7	+ 6
9	++ 6	++ 6	+ 3	+ 3																+++ 15	+++ 10	++ 8	+ 5	+++ 22	+++ 12	++ 10	-				
10	++ 7	+ 4	+ 3	-																-	-	-	-	++++ 26	+++ 15	++ 12	+ 5				
11	+ 5	+ 5	±	-																-	-	-	-	++++ 22	+++ 18	++ 12	+ 3				

N.=Necrosis.

M. Butyricum

The guinea-pigs were tested after 51 days, and with regard to their reactions to the homologous extract, the same remarks apply as in the case of M. stercoris. They did not react to the vole strain extract, but reacted to all other extracts in low dilutions only; to M. phlei, M. stercoris and M. smegmatis extracts slightly better than to others.

M. Smegmatis

These guinea-pigs, which were tested after 52 days, reacted very strongly to the homologous extract even in a dilution of 1 : 8,000. The centres of the swellings in some guinea-pigs, even in high dilutions, became markedly necrotic at the 48th hour. There was, however, no reaction to the vole strain extract. They reacted to other extracts in low dilutions only, except to M. stercoris, in which case reactions were rather more marked.

Summary and Conclusions

Guinea-pigs were sensitised with various members of the acid-fast group, in the case of pathogenic strains by the subcutaneous inoculation of saline suspensions of cultures, and in the case of the non-pathogenic strains by the intramuscular injection of liquid paraffin emulsions. Following the latter technique, it was found that a dose of 2-3 mgms. produced a high degree of sensitisation to homologous extracts, reactions being obtained sometimes in dilutions of 1 : 4,000 and over.

The extracts used in this experiment did not conform to any standard and therefore one might not be justified in drawing hard and fast conclusions. Still, if one considers the results in their entirety, certain facts stand out fairly clearly, justifying reasonable conclusions.

(1) There is a good deal of cross-reaction exhibited by guinea-pigs sensitised with the various acid-fast organisms. A guinea-pig highly sensitive to one organism will react to low dilutions of extracts from other acid-fast organisms. The saprophytic bacilli seem to be an exception, as guinea-pigs sentitised with these strains did not show any definite reaction to the vole strain extract. It may be that the cross-reaction exhibited by such guinea-pigs towards this extract is of an order lower than that shown by guinea-pigs sensitised with the pathogenic types and cannot be detected unless a very potent extract is used.

(2) Guinea-pigs sensitised with the vole strain react quite strongly to tuberculin prepared from human tubercle bacilli (and presumably also from bovine), even in a dilution of 1 : 200. Guinea-pigs sensitised with the human tubercle bacillus reacted to low dilutions only of the vole extract, but it must be remembered that this extract was presumably a weak one.

(3) Guinea-pigs sensitised with Johne's bacilli react equally well to johnin

and avian tuberculin. But the converse is not true, as guinea-pigs sensitised with avian tubercle bacilli react to johnin in low dilutions only.

(4) Guinea-pigs sensitised with the saprophytic strains show a greater tendency to exhibit cross-reaction towards extracts prepared from other members of the same group than towards those prepared from the pathogenic strains.

Some of these results are supported by one's experience in cattle. For instance, one knows that Johne's disease infected cattle will react to avian tuberculin, that highly sensitive tuberculous cattle will sometimes give a reaction to avian tuberculin, and that cattle injected with vole bacilli will react strongly to mammalian tuberculin. There is no definite evidence, however, that cattle become sensitised in nature with saprophytic strains. In the experiment described above a special method was used for producing sensitivity in guinea-pigs against such strains, but it is a moot point whether such sensitisation can occur spontaneously in nature through ingestion, say, of large numbers of bacilli and their subsequent localisation in the tissues. Entry into tissues through accidental wound infection, in the case of M. smegmatis particularly, is another possibility that needs to be considered. Perhaps the next step in the elucidation of this problem would be to study the reactions of guinea-pigs subjected to repeated injection or dosing with cultures of saprophytic acid-fast bacilli. If sensitisation could be proved to result from such treatment, it might serve to throw some light on those puzzling cases which one frequently encounters in the tuberculin testing of cattle, where indefinite reactions are obtained to mammalian or avian tuberculin, without definite evidence of disease at post-mortem.

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THE TERMINATION OF THE N. CUTANEUS ANTIBRACHII DORSALIS AND LATERALIS OF THE HORSE

By ALFRED GINSBERG, D.M.V.

Lwów, Poland.

THE writers who describe these nerves are satisfied with a brief mention of their terminations. They show little consideration of comparative anatomy, often their wording and illustrations are incomplete and faulty.

Because of the declaration of war, it was impossible for me to describe these observations, which I had commenced with Prof. Bant, Director of the Anatomy Department of the Veterinary College, Lwów, Poland.

At the beginning I should like to convey my sincere thanks to Prof. Grahame, Director of Anatomy Department of the Royal (Dick) Veterinary College, Edinburgh, for his great aid. With usual British hospitality, well known to us Poles, he has made it possible for me to enter his Department. Moreover, he has helped me to obtain the references for this work, which are so difficult to procure in war time.

In order to understand the anatomy of the forelimb of the horse it is necessary to know the comparative anatomy. Therefore, I shall give the normal description of the nerves and cutaneous branches, which supply the forearm and hand of man and the domestic animals. This will be the best way to understand reductions, modifications and transformations.

Man

(*a*) *The musculo-cutaneous nerve.*—". . . in its course it may send a branch under the biceps to join the median nerve. The branches of the nerve are muscular and cutaneous. The cutaneous branches are anterior and posterior. The anterior branch descends downwards so as to include the ball of the thumb. It communicates above the wrist with the radial nerve. The posterior branch passes backwards and downwards over the extensor muscles and supplies the skin on the outer aspect of the forearm posteriorly in its upper three-fourths, communicating with the cutaneous branches of the musculospiral nerve (n. radialis)."

(*b*) *The radial nerve* (*n. superficialis*).—Is entirely cutaneous in its distribution. It is distributed to the skin of the back of the hand, and the back of the thumb and outer two and a half fingers. Its branches communicate on the ball of the thumb with the musculocutaneous nerve, and on the back of the hand with the dorsal branch of the ulnar nerve. The digital branches are small.

(*c*) *The median nerve.*—In the arm the median nerve sometimes receives a communicating branch from the musculocutaneous nerve (which corresponds to the anastomosis found around the axillary artery of the horse).

Carnivora

(*a*) *The musculocutaneous nerve.*—Is well developed. On the medial surface of the elbow articulation it sends a branch to the median nerve.

(*b*) *The radial nerve.*—Gives off a large cutaneous branch, which runs with the v- cephalica anti-brachii to the toes. It divides into two branches, one medial and the other lateral, which give off the Nn. digitales comm. dorsales. These nerves form the dorsal nerves of the toes. From the medial branch arise the two dorsal nerves of the first toe and the medial dorsal nerve of the second toe. The remaining dorsal nerves are derived from the lateral branch, with the exception of the lateral nerve of the fifth toe, which comes from the ulnar nerve.

XUM

(*c*) *The median nerve.*—Divides into the Nn. metacarp. volares I, II and III, which combine on the distal part of the metacarpus with the corresponding Nn. digitales volares comm.

Pig

(*a*) The cutaneous branch of the *radial nerve* is similar to that of ruminants.

(*b*) *The median nerve.*—Splits into a lateral and medial branch to the toes.

Ruminants

(*a*) *The radial nerve.*—Has a large cutaneous branch called the N. cutaneus antibrachii dorsalis, which passes to the toes. Over the carpal articulation it anastomoses with the N. cutaneus antibrachii lateralis (in man it is slightly more distal).

(*b*) Slightly distal to the middle of the metacarpus the median nerve splits into two branches, the medial and lateral, which supply the toes.

The modification of muscles, vessels and nerves is due to the reduction of the bones of ungulates. In the textbook, "The Limbs of the Horse," Bradley describes this process as follows: ". . . in his examination of the rest of the limb, the dissector should constantly bear in mind that he is dealing with an animal in which evolution has produced profound modifications. Inasmuch as the digits have been reduced in number to one only, the horse is as far removed as he conceivably can be from the typical pendactyl mammal. In association with the disappearance of all the digits except one, the metacarpal bones have been modified. The first and fifth metacarpals have disappeared entirely. The second and fourth are represented by comparatively slender and tapering rods, which fail to stretch the full length of the metacarpal region. . . . The third metacarpal bone has been transformed in the opposite direction. It has increased in length and strength and, like the phalanges it carries, has attained a considerable volume . . . the modern horse is no longer digitigrade: it is unguligrade.

Descriptions of the cutaneous branches of musculocutaneous and radial as well as that of the median nerve and their accompanying illustrations are so different, that it may be beneficial to cite passages from a few textbooks of anatomy.

Bradley, "The Limbs of the Horse": ". . . from that part of the radial nerve which is now visible arise a cutaneous branch (N. cutaneus antibrachii dorsalis) that either passes through the lateral head of the triceps or emerges from beneath the distal border of the muscle, and is distributed over the lateral and anterior part of the forearm.

"The lateral cutaneous nerve of the forearm (N. cutaneus antibrachii lateralis) left the median about the middle of the arm, and is now seen to be

distributed over the anterior and medial aspects of the forearm, carpus and metacarpus."

Sisson and Grossman, "The Anatomy of the Domestic Animals": "In this part . . . it gives . . a cutaneous nerve (N. cutaneus antibrachii dorsalis) . . . and ramify on the dorso-lateral surface of the forearm."

Fig. 652 (b) shows that the cutaneous branch ends in the proximal half of the forearm.

"(median nerve) . . . the cutaneous branch . . . descend on the fascia of the forearm with the cephalic vein and its accessory, and ramify on the front and medial face of the forearm, carpus and metacarpus."

The illustration Fig. 652 (d) which accompanies the above passage shows that the cutaneous branch of the median nerve only passes to the distal epiphysis of the forearm and not the metacarpus as mentioned in the text.

Chauveau, "The Comparative Anatomy of the Domesticated Animals": "(radial nerve) . . . and that it endows the integument of the anterior antibrachial region with sensibility."

The attached illustration, Fig. 347, shows only the beginning of this nerve, but not the termination. Neither in the text, nor in the illustrations, can one find a name for this branch.

"(median nerve) . . . in its course, this nerve successively furnishes, at the middle of the humerus, a long branch, represented in man by that portion of the musculocutaneous nerve which proceeds to the anterior brachial muscle and the skin of the forearm . . . when it breaks up into two principal filaments, which pass to the external face of the antibrachial aponeurosis, and accompany with their divisions the two subcutaneous veins of the forearm to below the carpal region."

The accompanying illustration, Fig. 347, shows the nerve as the "antibrachial musculocutaneous branch and superficial ramuscules of that branch," which terminates over the carpal articulation. The real name of this nerve is missing in the description.

Bourdelle, Bressou, "Anatomie Régionale des Animaux Domestiques": "The anterior brachial nerve represents the musculocutaneous nerve of man . . ."

"The subcutaneous nerves come from the musculocutaneous nerve, which is a branch of the median and brachial cutaneous . . . gives branches to the surface of the forearm."

Fig. 324 (11, 18) shows the musculocutaneous nerve only passing to epicondylus distalis of the forearm. The authors do not give this cutaneous branch a special name. They describe the radial nerve without referring to the cutaneous nerve, the N. cutaneus antibrachii dorsalis.

Martin, "Lehrbuch der Anatomie der Haustiere": "(musculocutaneous nerve) . . . the greater part passing over to the median nerve."

XUM

" (radial nerve) . . . the N. cutaneus antibrachii dorsalis . . . pass to the carpus and are distributed in the skin."

" (median nerve) . . . N. cutaneus antibrachii lateralis . . . it supplies principally the skin on the anterior surface of the forearm, carpus and metacarpus."

The author accompanied these descriptions with a diagram, which shows the nerves of the distal half of forearm, carpus, metacarpus and phalanges, Fig. 482. The N. cutaneus antibrachii dorsalis gives branches to the skin of the anterior and medial surfaces of the carpus and metacarpus, with a termination at the epicondylus distalis metacarpei III. In the illustration the N. cutaneus antibrachii lateralis is completely missing. Consequently the N. cutaneus antibrachii dorsalis completely occupies the area of the N. cutaneus antibrachii lateralis, which is impossible, and does not correspond to the actual facts.

Ellenberger & Baum, "Handbuch der vergleichenden Anatomie der Haustiere."

"(musculocutaneous nerve) . . . and in man and in carnivors it gives off, after supplying the N. brachialis, the N. cutaneus antibrachii lateralis, which in other domestic animals branches off from the median nerve, supplying the skin on the dorsomedial surface of the forearm."

Here the authors state emphatically that the N. cutaneus antibrachii lateralis is a cutaneous branch of the median nerve.

"(radial nerve) . . . the cutaneous nerves . . . spread out . . . in the middle and proximal third of the lateral aspect of the forearm (Nn. cutanei antibrachii dorsales hom.)" and there, according to the authors, the nerve ends.

" median nerve) . . . the N. cutaneus antibrachii lateralis . . . gives off branches to the skin of the forearm, carpus and metacarpus."

Together with these descriptions the authors give a few illustrations: Fig. 1226 (b) shows the Nn. cutanei antibrachii dorsales as stated above, reaching the proximal half of the forearm (d). The end branches of the N. cutaneus antibrachii lateralis pass only to the carpus and do not reach the metacarpus as stated in the text. Fig. 1225 (7) shows the median nerve and (8) its "cutaneous nerve," reaching to the distal quarter of the metacarpus III. According to the illustration, this "cutaneous nerve" is the N. cutaneus antibrachii lateralis, which they say is a branch of the median nerve and furthermore they call it "its cutaneous nerve." Consequently they separate this nerve completely from the musculocutaneous nerve. Fig. 1224 (16, 17) shows again the median nerve and the N. cutaneus antibrachii lateralis, which however only reaches here to the distal epicondylus of the radius. In the same illustration is also the N. cutaneus antibrachii dorsalis with a termination at the proximal half of the radius. Fig. 1213 is a diagram which shows the skin innervation of the distal third of the radius, carpus and metacarpus.

According to the illustration all these parts on the proximal and medial surface are supplied by the N. cutaneus antibrachii lateralis. They are absent on the distal third of the radius.

All these descriptions and illustrations differ, and for the most part are not complete, and also wrong. Even the same textbook has differences in text or illustration or vice versa. For instance, we can find in Martin's textbook a very exact description about the innervation of the forelimb, but in Fig. 482 there is a big contrast, which does not take into consideration the N. cutaneus antibrachii lateralis, but accords the medial and proximal surface of carpus and metacarpus to the branches of the N. cutaneus antibrachii dorsalis. Also in the textbook of Ellenberger & Baum, each illustration shows the ending of the N. cutaneus antibrachii dorsalis and lateralis in another position. For instance, Fig. 1226 shows the N. cutaneus antibrachii lateralis reaching the carpus, whereas the same nerve passes in Fig. 1213 to the distal epicondylus of metacarpus III. Bourdelle, Bressou do not speak about the N. cutaneus antibrachii dorsalis. Sisson & Grossman give in their textbook a good description about manus innervation "and medial face of the forearm, carpus and metacarpus"; however, the accompanying illustration, Fig. 625, is contradictory and shows the N. cutaneus antibrachii lateralis only reaching to the carpus. In the same unclear way Chauveau, Martin and Ellenberger-Baum describe the origin of the N. cutaneus antibrachii lateralis and its relation to the musculocutaneous nerve or to the median nerve. Reading each description it is impossible, especially for students, to understand the relation between the musculocutaneous nerve of man and the horse. It is not explained sufficiently clearly to which nerve the N. cutaneus antibrachii lateralis belongs. A very accurate description I have found only in Bradley's, Sisson & Grossman's, and Bourdelle-Bressou's textbooks. These descriptions agree with the observations of Agduhr and myself, which we were making in the study of the musculocutaneous nerve.

Bradley describes this as follows: "Although, for the sake of convenience and because of its obvious origin, this nerve is here described as a branch of the median, there is reason for assuming that, morphologically, it is part of the musculocutaneous nerve. The fibres composing it apparently become separated from the other components of the temporary fusion of this nerve with the median."

Sisson & Grossman: "... the musculo-cutaneous branch is in reality the continuation of the nerve of that name." In contrast to this exact description, the authors give in Fig. 652 (d), a false explanation calling the N. cutaneus antibrachii lateralis 'cutaneous branch of median.'"

Agduhr: "Therefore there seems to be no cause to give the name 'musculocutaneus,' which is borrowed from human-anatomy, only for one part of the homologous structure in the horse. Therefore the N. cutaneus anti-

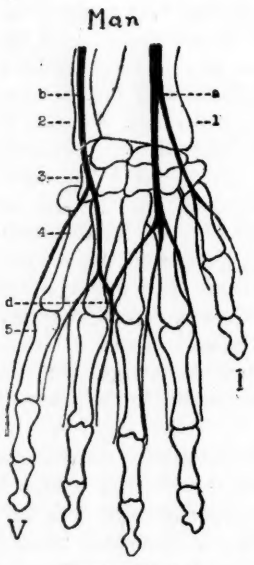

DIAGRAM No. 1.

a. Ramus superficialis (n. radialis).
b. Ramus dorsalis manus (n. ulnaris).
d. N. metacarpeus/or digitalis/dors. communis III.
1. Radius. 2. Ulna. 3. Carpus. 4. Metacarpus. 5. Phalanges.
—Ellenberger & Baum.

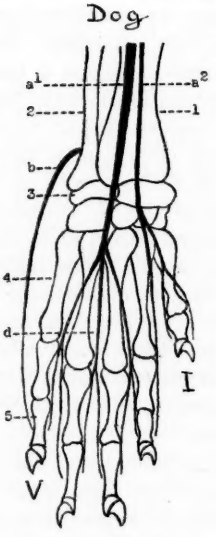

DIAGRAM No. 2.

a1. Ramus ulnaris (n. radialis).
a2. Ramus radialis (n. radialis).
b. Ramus dorsalis manus (n. ulnaris).
d. N. metacarpeus/or digitalis/dorsalis communis III.
1. Radius. 2. Ulna. 3. Carpus. 4. Metacarpus. 5. Phalanges.
—Ellenberger & Baum.

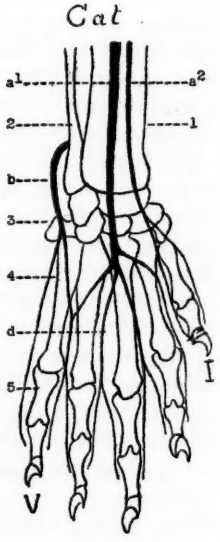

DIAGRAM No. 3.

a1. Ramus ulnaris (n. radialis)
a2. Ramus radialis (n.. radialis).
b. Ramus dorsalis manus (n. ulnaris).
d. N. metacarpeus/or digitalis/dorsalis communis III.
1. Radius. 2. Ulna. 3. Carpus. 4. Metacarpus. 5. Phalanges.
—Ellenberger & Baum.

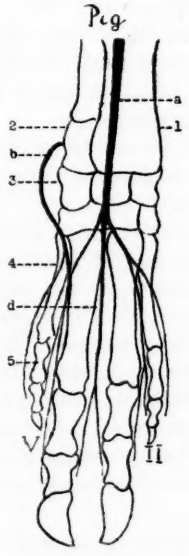

DIAGRAM No. 4.

a. Ramus superficialis (n. radialis)
b. Ramus dorsalis manus (n. radialis).
d. N. metacarpeus/or digitalis/dorsalis communis III.
1. Radius. 2. Ulna. 3. Carpus. 4. Metacarpus. 5. Phalanges.
—Ellenberger & Baum.

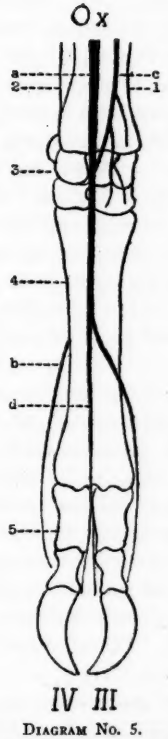

DIAGRAM No. 5.

a. Ramus superficialis (n. radialis).
b. Ramus dorsalis man. (n. ulnaris).
d. N. metacarpeus/or digitalis/dorsalis communis III.
1. Radius. 2. Ulna. 3. Carpus. 4. Metacarpus. 5. Phalanges.
—Ellenberger & Baum.

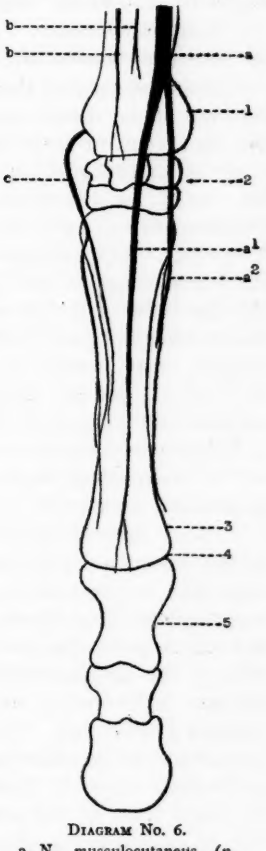

DIAGRAM No. 6.

a. N. musculocutaneus (n. cutaneus antibrachii lateralis).
a2. Ramus medialis.
a1. Ramus proximalis.
b. N. cutaneus antibrachii dorsalis (n. radialis).
c. Ramus dorsalis (n. ulnaris).
1. Radius. 2. Carpus. 3. Metacarpus. 4. Articulatio phalangis primæ. 5. phalanges.
—Ellenberger & Baum.

brachii lateralis of the horse is a branch of the N. musculocutaneous and not of the median, as it is now accepted."

Bourdelle-Bressou: "... the anterior brachial nerve of horse represents the musculocutaneous of Man."

In consequence of these differences I had started to observe the terminal branches of the radial, median, and musculocuateous nerves of the horse. I will endeavour to show how much these nerves are modified through the reduction of bones of horse. My dissections have been carried out only with the use of the naked eye. Perhaps with the aid of the microscope the cutaneous nerves could be shown to have more profuse endings. (Matsuba & Hiroye). My observations have been prolonged throughout a period of five years owing to the difficulties in procuring material. I have dissected 283 forelimbs of the horse, from different breeds, as follows: 160 Hucul-Polish mountain ponies, 20 Arabs, 6 English thoroughbreds, 18 French and Belgian heavy breeds, 76 cross-breeds, and in the dissection room of the R.(D)V.C. 3 ponies. As a fundamental comparative anatomical procedure I examined these nerves in the ox, pig, dog, monkey (1), and man.

From my observations I am able to give the following description of the nerves which supply the medial and proximal surface of distal third of radius, carpus, and metacarpus.

1.—*N. Musculocutaneus,* or as named in textbooks, N. cutaneus antibrachii lateralis (hom) emerges between M. biceps brachii and M. brachiocephalicus on the surface of the fascia of the forearm; it divides into two branches which run downwards with the V. cephalica accessoria. The proximal branch passes the dorsal aspect of the carpus and gives branches to the skin of the proximal and proximo-lateral surface of the metacarpus III. The terminal branches reach the articulatio-metacarpo-phalangeal (articulatio phlangis primæ) (a^1). The second medial branch passes the medial aspect of the carpus and metacarpus and gives branches to the skin of the medial and medio-volar aspect of these parts. The terminal filaments reach in most cases the distal third of the metacarpus III (a^2).

The nerve is connected with the median nerve by strands of connective tissue. Neither Agduhr nor myself has observed nerve filaments which cross over from one nerve to the other. The muscular branch has the same termination as that of man. It seems that in the horse there are inconsistent ramus anastomoticus from the musculocutaneous to the median nerve (Baum, Agduhr), homologous to the ramus anastomoticus of man. The cutaneous branch of the N. musculocutaneus is connected by a longer section with the median nerve than that of man, but also only with connective tissue. Therefore, I think that it is absolutely appropriate that this must be described also in the horse as a branch of the median nerve.

The name "lateralis" is deceptive because in the horse the nerve is medial

in position due to the medial turn of the forelimb. It seems better perhaps in the anatomy of domestic animals to exclude this name and to speak only of the musculocutaneous nerve (muscular branch and cutaneous branch). Consequently due to the modification of the limb the termination of the musculocutaneous nerve is more proximal and only reaches the articulatio phalangis primae.

2.—*N. cutaneus antibrachii dorsalis.* The cutaneous branches of the radial nerve emerge on the surface at the distal border of caput laterale of the M. triceps brachii and supply by small branches the skin of the arm and especially that of the proximal aspect of the forearm. The terminations of these cutaneous branches are at the epicondylus distalis of the radius and very often also at the first row of carpal bones. In a few specimens I was able to see the terminations passing over the proximal epicondylus of metacarpale III (Matsuba and Hiroye have observed under the microscope a more distal termination of this nerve).

Conclusion

The results of our observations of the endings of the N. cutaneus antibrachii dorsalis (N. radialis) and N. cutaneus antibrachii lateralis (N. musculocutaneus) are, from a comparative anatomical view, as follows:

1.—Consequent upon the reduction of the metacarpal and finger bones and medial turn of the forelimb of the horse the radial nerve has lost its original termination. The terminal branches reach the distal epicondylus of the radius or more rarely the first row of the carpal articulation. The area, more distal to the carpal articulation is supplied by the N. cutaneus antibrachii lateralis (it is possible that over the carpal articulation small branches of the N. cutaneus antibrachii lateralis and dorsalis anastomose).

2.—The proximal and medial aspect of the distal third of the forearm of the horse is supplied by the N. cutaneus antibrachii dorsalis and lateralis. The proximal and medial aspect of the carpus and metacarpus of the horse by the N. cutaneus antibrachii lateralis.

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Clinical Articles

CLINICAL CASES

By D. KIRK and M. KIRK, Ms.R.C.V.S.
Taunton, Somerset.

1. A Tubercular Goat

THE case was a six-year-old pet goat that was said to be off its food, and very listless. On examination of the animal we found it to be suffering from pneumonia of both lungs, and in view of its physical condition we diagnosed tuberculous pneumonia. We advised slaughter because the premises also housed two tuberculin-tested cattle.

Post-mortem examination revealed extensive pneumonia of both lungs, with calcification. We sent the lungs and mesenteric glands, which were also involved, to the R.V.C. Pathological Department, and they confirmed that smears stained Ziehl Nielson revealed clumps of acid fast organisms. Frozen sections showed the typical features of T.B. lesions—necrosis, caseation, calcification, giant cells, endothelioid cells, and lymphocytes.

Cultural examination of the organisms on egg and glycerine egg media, and sub-culture after guinea-pig inoculation, confirmed tuberculosis, proved the type to be bovine.

The remarkable feature of this case was that this goat had been subjected to the double intradermal tuberculin test with bovine tuberculin six weeks previously, and had given no sign of a reaction.

Out of interest, we traced the goat, and found that it had had five owners, but we were not able to establish where the infection had been picked up.

2. Successful Treatment of Laceration of Four Teats in a Dairy Cow

The animal when seen was bleeding from all four teats, and the owner told us that she had stumbled across a barbed-wire fence a couple of hours previously. Examination disclosed that two of the teat ducts had been exposed and split open in their length for a distance in each case of about half an inch. The other two teats had deep lacerations which did not involve the ducts.

We decided to treat them all in the same manner, as follows. We washed the wounds thoroughly with a mild antiseptic solution and smeared them with an ointment containing calamine, salicylic acid and zinc oxide. We then completely enclosed each teat in Elastoplast bandage, and gave instructions that

the animal was to be milked by hand in the normal way. She made a marvellous recovery, the bandages being removed in ten days, and healing had been by first intention. No further attention was necessary, and the cow was actually back in the shed and being milked by a machine fifteen days after the accident.

3. Inguinal Hernia Operation in a Cow

This was one of the "by the way" cases that are met daily; by this we mean that the farmer says "by the way, while you are here you might have a look at this." The cow had been noticed for several days to have a swelling on her flank, just in front of, and a little to the side of, her udder. The farmer suspected an abscess, and had hoped that it would burst without assistance, but as the cow had commenced to drop in her milk yield and had gone off her food completely, he decided to seek assistance.

The swelling was about the size of two rugby footballs, and on palpation seemed to contain a quantity of fluid and an oblong solid core. It was possible to reduce the fluid by pressure, but the core would not move. A diagnosis of inguinal hernia was made.

After evacuation of the fluid by pressure, an attempt was made by tight bandaging to cause the solid to slip back into the abdomen, but it failed because the bandage always slipped one way or the other.

In an extensive search of available literature, we found only one case of inguinal hernia in a bovine reported, in which three veterinary surgeons in Sussex had attended a valuable bull and advised slaughter. However, as this cow was ten years old and not valuable, the farmer decided not to spend any money on it, and arranged to send it to the kennels. We persuaded him to lend it to us first for experimental operation, as we saw no logical reason why the abnormality should not be rectified surgically.

The cow was cast and chloroformed, and secured on its back, the site cleaned and an incision about seven inches long made in an antero-posterior direction. Diagnosis was immediately confirmed, there being about five feet of small intestine in the sac, as well as a lot of fluid. Most of the bowel slipped back quite easily, but the solid core that had been apparent before operation proved to be infiltration of fluid into the connective tissue surrounding a piece of intestine about eight inches long, and forming a thickening that it was quite impossible to slip back through the inguinal canal.

Consequently it was necessary to cut the muscle a little, and thus complete reduction was achieved. The muscular gap was then roughened along its edges with a scalpel and closed by suture with strong silk. The skin incision was similarly closed and the cow released.

Next day the sac was as big as before, but as palpation revealed no solid, two of the stitches were removed and about two gallons of fluid escaped.

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The animal now progressively recovered, but in three days pus began to flow from the wound, and another two stitches were removed and the sac syringed with warm glycerin and acriflavine. After a fortnight a complete recovery of the wound had occurred, and the operation was considered to have been successful in itself.

Unfortunately the cow never came back to normal milk yield (she had been giving three gallons and now gave only one), and she was suffering from chronic indigestion.

Ten weeks after the operation she was destroyed as she was obviously not improving, and post-mortem examination revealed the cause of the indigestion to be the section of bowel infiltrated with fluid. This was now exactly as it had been when put back into the abdomen, and was obviously causing partial stoppage.

The operation wound had healed perfectly, and we can recommend an attempt at surgical correction of such cases.

Abstracts of Current Literature

Gibt es Geisteskrankheiten auch bei Tieren? (Are Animals subject to mental diseases? [aberrations of psyche]). By E. Frauchiger. *Schweiz. Arch. Tierhlk.* (1940), *82*, 286-293.

THE question forming the title of this article has been answered both positively and negatively in the past. There are treatises dealing with animal psychiatry (Sommer; Hammer), and proposals have been made to establish asylums for insane animals. There are, however, others, and particularly psychiatrists, who are of the opinion that aberrations of psyche in animals could not possibly become a suitable subject of scientific investigations (Dexler).

The author, a medical man himself, holds the view that, although animals can experience and show joy, yearning, love, affection, grief, anger, etc., they possess no psyche in the sense accepted by alienists, and that, therefore, aberrations of behaviour should be classified not on the mental plane but together with the diseases of the central and autonomous nervous systems of which they are undoubtedly the symptoms. Narrowing his field of inquiry to domestic animals alone, he says that they possess brain which differs from that of man, not functionally but in the degree of differentiation only.

Dealing in detail with the anomalies of behaviour, he mentions the cataleptic and stereotypic postures and movements observed in horses suffering

from Borna disease; cites a few instances of epilepsy and idiocy in dogs, horses and cattle; discusses cases of mass and individual neuroses and psychoses, such as mass panic or frenzy and fright of horses and cattle during fires or under bombardment, and anxiety neuroses, such as fright disease of dogs. He concluded that from the examples he quoted it is manifest that animals can, in analogous circumstances, like human beings, show aberrations of behaviour known as psychoses, but that there exist no mental diseases amongst animals in the accepted meaning of the term.

A blasted horse—and others. A letter to the Editor. By H. F. Buxton. *Lancet* (1941), *240*, No. 6, 130, 261.

The author records the history of a gelding which, with another fourteen horses, was housed in a stable near which a H.E. heavy bomb exploded on one occasion, and which received a direct hit on another.

On the first occasion two out of fourteen animals became unconscious after the explosion; one, aged eleven, recovered in two hours after massage treatment, was at work forty-eight hours later, and suffered no permanent ill effects. The gelding lay as dead for over four hours, and showed such a slow pulse that it was decided to destroy it; suddenly it shivered all over and got up, but could not use hind quarters to walk. Fomentation and massage were applied, and a week after it was able to do light work, constantly needing rest days, but working four days out of six; there was slight lameness confined to both hind limbs.

Later, when the stable received a direct hit, the gelding had a bad relapse. A month after the occurrence it could not back and turn, showing the signs of incomplete spinal paralysis. The animal is still under treatment and observation, and it will be at grass during the summer.

Other animals in a country district were affected after aerial torpedoes had been dropped. The rabbits—even in their holes—suffered from shock and hopped out of them aimlessly and could be picked up by hand. The cows similarly behaved in a dreamy way, refused to eat, and had to be slaughtered.

Comparative psychology. Annotation. *Br. Med. J.* (1941), No. 4, 181, 284.

Repeating a warning that it is fallacious "to argue from mice to men," the author nevertheless deplores the fact that we have to go abroad, and especially to the U.S.A., for experimental studies in animal "psychology," which have flourished there under the stimulus of the pre-eminently American psychological system, Watson's behaviourism.

Another approach to animal psychology, that of Pavlov, has also been increasingly employed in a number of centres in the U.S.A., while it is doubtful whether a single laboratory has existed in this country for this purpose.

The experiment may amount to nothing more than a demonstration that what happens in humans has its parallel, or, at any rate, its analogue, in

animals. For example, it has been shown by American investigators (study of "regression") that under the influence of pain an animal may revert to a mode of behaviour ("dissolution of habit") previously learned, although less effective for the task in hand than a method more newly acquired.

Nowhere does this strike the observer more forcibly than in Pavlovian experiments on the production of "neurosis" in dogs. But even here there is a satisfaction in demonstrating that pathological signs of behaviour can arise, not from lesions, but from a conflict of impulses in the cerebrum. The fact that an animal which has learned two ways of getting at food drops one of these when it finds the method painful, and reverts to the previously learned one, seems not to be "regression" in the sense known in human psychopathology; it is surprisingly sensible—not in the common sense—but in Starling's sense of the "wisdom of the body." The animal chooses not so much a regressive as a different path.

The author hopes that the war may give us as a people a greater interest in the uses of science as a means of social amelioration rather than of destruction; and that some of the increased wealth that Mr. Keynes paradoxically promises us after the war may be devoted even to such remote and apparently academic studies as experimental animal psychology.

Reviews

The Principles and Practice of Feeding Farm Animals (with a Special Chapter on Feeding in War Time). By E. T. HALNAN and FRANK H. GARNER. London: Longmans Green and Co. Price 15s.

We have come to expect practical and useful contributions concerning agriculture from Cambridge, and in this publication we are not disappointed. The authors, whose names are well known in the agricultural world, have produced a work in which the important subject of the feeding of livestock is dealt with in simple language. The work is divided into two sections, (A) Theoretical Consideration (Chapters 1-4) and (B) Practical Considerations (Chapters 5-16), with certain appendices and an index. The two sections are closely inter-related and carry the reader from the scientific aspect of the subject to its practical application. The volume is full of every-day observations, and it is very obvious that the writers have a close acquaintance with their subjects. This publication will be found useful to all interested in the feeding of livestock, whether from a scientific or practical point of view. The veter-

inary profession will find much of importance in its pages, and we recommend it to our readers.

The book is well illustrated, and it contains tables throughout the text and in the appendices, essential to those interested in nutrition work. Here and there throughout the book reference is made to disease which may be set up by errors in diet: these references are not extensive, and when a new edition is prepared the authors might consider some additions. An important chapter, included after the book had been prepared, deals with feeding in war time, and will be found of much value to all concerned with livestock.

Man's Greatest Victory Over Tuberculosis. By J. ARTHUR MYERS, Ph.D., M.D., F.A.C.P. Pp. x, 419. 31 illustrations, including plates. Springfield, Illinois: Charles C. Thomas. Price £1 7s. 6d.

The book consists of 26 chapters with a bibliography, an index and a foreword by Dr. J. R. Mohler. In his foreword, Dr. Mohler writes: "I earnestly trust that the facts that Dr. Myers presents and opinions he expresses may provide a fund of knowledge that will mould public opinion with benefit to the onward course of civilisation." After a perusal of the book we can confidently say that this publication should go far to fulfill the hopes expressed by Mohler. The volume is essentially a detailed account of the great part played by the veterinary profession in controlling and eradicating tuberculosis in cattle. The author is loud in his praises of the work of the veterinary profession. For example, after discussing the life history of some of the pioneers in the field of tuberculosis, he states "The work of the leaders and discoverers, only a few of whom have been mentioned, was of great importance. Yet the veterinarian who carries on the program and conducts the work on individual farm or stockyard is equally important from the standpoint of actual accomplishment. For example, as great as the discovery of the tubercle bacillus and the preparation of tuberculin were, they would have been of little value were it not for the fact that thousands of veterinarians whose names rarely appear beyond the confines of their local communities actually used the microscope in diagnosis and administered the tuberculin test. The veterinarian is an important citizen in his community, for he not only administers treatment to ill animals, but prevents many contagious diseases, and thus is one of the active protectors of human health in his community and his nation." Truly an admirable tribute.

The author has spared no pains to obtain his facts. Practically all the notable events in the study of tuberculosis are given in detail, as well as abstracts and extracts of speeches and articles relating to some of the rather troublous criticisms to which the various claims were subjected. Naturally, much of the details concerning such subjects as eradication schemes relate to America, but references are also made, and in some cases in detail, to work

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carried out in other countries, including our own. The names of Fleming, M'Fadyean, Stanley Griffith and others frequently appear, due credit being given to all whose work has been of merit. Although tuberculosis occupies most of the volume, the first few chapters deal with more general subjects, e.g., a description of some of the important diseases of animals, the N.S. Bureau of Animals Industry, and three chapters devoted to veterinarians and their work.

The style of the author makes easy reading, and his method of leading from one phase of the subject to the next is fascinating. It is a long time since we have read a book with more information easy of assimilation. There is an abundance of material for everyone interested in tuberculosis, and we have no hesitation in recommending this work to our readers, both as a source of information for reference and as an interesting literary contribution.

Correspondence

To the Editor of THE VETERINARY JOURNAL.

Dear Sir,—I have read with interest Mr. Sahai's paper and that of Mr. Taylor published in the VETERINARY JOURNAL, on the experimental infection of small laboratory animals with Mycobacterium paratuberculosis suspended in liquid paraffin. Following Mohler's report on that subject in 1939, I was asked by Prof. Rinjard, Director of the Laboratoire National des Recherches Vétérinaires (Alfort, France), to carry out some research on the value of Mohler's results regarding the diagnosis of Johne's disease in cattle.

The following experiments were devised and carried out:

Experiment No. 1

A young culture, one month old, of Johne's bacillus (grown on potato with Sauton fluid and glycerinated extract of M. phlei) was dried between several sheets of sterilised filter paper. A given weight of these bacilli was then placed in a flask and ground with glass beads for two hours in a special rotation machine. Sufficient saline was allowed—sufficient only to wet the glass beads—at the beginning of the operation. This grinding procedure is effective in separating the micro-organisms from one another, thus facilitating their suspension in mineral oil. The latter was added in appropriate quantities and rotation was again employed for half an hour; a final liquid paraffin preparation containing 10 mgs. of bacilli per c.c. was obtained—secondary organisms having been excluded during the whole operation.

Ten guinea-pigs received intraperitoneally various doses (0.5-2 c.c.) of the above suspension. Allergic reactions, as indicated by intradermal injections of johnin, were irregularly observed. During the seven months of observation the inoculated animals remained relatively in good condition. They were progressively slaughtered after the first month, and careful post-mortem examination carried out immediately showed lesions localised in the abdominal cavity. Whitish nodules appearing as multiple specks of fat of variable size from a rice seed to a pin point were observed on the surface of the peritoneum and on the capsule of liver and spleen; they became united in confluent masses on the abdominal organs and on the omentum, producing in most cases adhesions between the stomach and spleen and the left kidney. A slight clear peritoneal exudate containing whitish flakes was constantly present in those animals killed before the 60th day. Section of the above-described pseudo-nodules revealed macroscopically mineral oil droplets, and microscopically acid-fast bacilli; these were progressively replaced by degenerated bodies, mostly visible as numerous acid-fast granules.

Our repeated attempts to culture the organisms on Lowenstein's malachite green egg media soaked with a glycerin extract of M. phlei (Boquet, 1939), carried out after the first month, were always unsuccessful.

The lesions described above underwent progressively a fibrous organisation, in a few cases localised suppurative foci were to be seen on section of some pseudo-nodules, and of the mesenteric lymph glands.

This experiment was repeated on another batch of guinea-pigs, and similar results were obtained.

Identical peritoneal reactions were produced in guinea-pigs which had been injected with M. phlei or an avirulent strain of M. tuberculosis (equine strain of Vallé) suspended in liquid paraffin. Hagan and Levine studied the nature of the lesions and pointed out as far back as 1932 that they are not specific of any special member of the acid-fast group.

Experiment No. 2

A sample of bovine fæces sent to the laboratory for diagnosis was found to contain numerous Johne's bacilli. They were concentrated by fractional centrifugation and treated by Lowenstein's technique (10 per cent. sulphuric acid for 10-15 minutes at 37 degrees C., neutralisation and centrifugation), and then broken down with glass beads and suspended in liquid paraffin. Ten guinea-pigs were injected intraperitoneally and subcutaneously with both one and two c.c. of the above preparation containing microscopically M. paratuberculosis.

Similarly *two* other samples of bovine fæces containing respectively numerous and few clumps of Johne's bacillus were simply ground with saline and centrifuged, and the deposits were directly suspended in liquid paraffin;

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each of the suspensions was inoculated intraperitoneally into three guinea-pigs in doses of 2 c.c.

After prolonged observation, about 90 days, the animals in the three groups were killed. Lesions similar to those described above were detected, but were not as extensive or as regular in their production as in the guinea-pigs of experiment No. 1. Cultures of pseudo-nodules of the omentum of mesenteric glands and spleen carried out on the guinea-pigs of the first group only did not yield any growth of M. Johne. Secondary infections killed some animals, but the lesions were not due in any way to Johne's bacillus but to intercurrent infections diagnosed by culture.

L. Sahai concludes from a series of experiments that cultures of M. paratuberculosis (2½ months old or more), suspended in liquid paraffin, produce extensive lesions somewhat similar to those reported above when inoculated intraperitoneally into small laboratory animals. In contradiction to Mohler's findings, however, these animals do not die. Moreover, he found that the lesions are not specific, as they are produced with other members of the acid-fast group (M. phlei and M. tuberculosis human type).

A. W. Taylor suspended ovine intestinal scrapings containing large numbers of Johne's bacilli in liquid paraffin after preliminary treatment with antiformin, and observed that after intraperitoneal injection the guinea-pigs died and showed pseudo-nodular lesions similar to those described by Mohler. No culture work was attempted by this author to ascertain whether the cause of death was not due to intercurrent infection and that the specific bacilli found at the post-mortem were viable.

Our experiments do not confirm the value of a paraffin suspension as a detector of Johne's disease. It has to be borne in mind that our oily suspensions of the culture organisms were relatively poor in bacilli (10-20 mgs.), compared with the huge doses (about 1 gram) used by Mohler. But we had in view the diagnosis of the disease in field cases, and concentrations such as 10-20 mgs. being heavier than any we can expect to find in bovine fæces or lymph nodes, we see no value—in view of our negative results—in the oily suspension of pathological samples for the diagnosis of Johne's disease.

Mohler suggests that the allergic reaction observed in small animals (after the injection of M. paratuberculosis in liquid paraffin) may help to standardise johnin. Glover has recently reported encouraging results by the use of guinea-pigs (400 grams in weight) sensitised with an intraperitoneal injection of 30 mg. of M. paratuberculosis in liquid paraffin. But, as with other similar biological products, johnin will still benefit by having its potency *finally* tested on the species of animal for which it is intended—preferably on bovines affected with the disease or adult cattle sensitised by a subcutaneous injection of a liquid paraffin suspension of M. paratuberculosis (Vallée and Rinjard and Glover).

In conclusion, M. paratuberculosis or bovine fæces containing the organism, when suspended in liquid paraffin, did not produce fatal or diagnostic lesions in guinea-pigs following intraperitoneal injection. The benign peritoneal reaction which follows such an injection is not specific, as it was produced with other acid-fast organisms (M. phlei and an avirulent strain of M. tuberculosis).

I am, Sir,

Yours, etc.,

MAURICE LEVI, Dr. Vet.

Formerly Assistant in the Laboratoire National des Recherches Vétérinaires, Alfort, France.

March 24, 1941.

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Note

THE FERTILITY OF A PARALYSED COCK AND HEN TREATED WITH IODINE

By ERNEST GRAY

Assistant Director, Veterinary Research Laboratories.

IT was reported in the VETERINARY JOURNAL, Volume 96, No. 1, pp. 28-34, that in a certain number of instances poultry showing the clinical nervous symptoms of lymphomatosis had recovered after two injections of 5 c.c. of a 10 per cent. solution of potassium iodide in distilled water, given on two successive days. The majority of such cases did not relapse, and after seven months two of the original cases of complete recovery, a cock and a hen, were mated. Eggs laid by the hen proved to be fertile, and from a clutch of a dozen selected eggs, 12 chicks were hatched in the incubators of the poultry

department of the Essex Institute of Agriculture. The chicks were reared under a Putnam Hover until six weeks of age, when they were placed out of doors in a wooden house with an earth floor. One chick died at two weeks of age, and a post-mortem examination revealed fatty degeneration of the kidneys, probably the result of chilling, since no parasites were found, and a bacteriological examination proved negative. All the other chicks did well and are now birds of 10 months of age. Their health and that of the parents is good, neither the cock nor the hen having shown any recurrent symptoms of paralysis. Of significance, perhaps, is the fact that this batch of 11 birds contains seven cockerels and four pullets. The recovery and subsequent fertility of apparently incurable cases of fowl paralysis has been experienced also in certain instances by farmers applying the method of treatment in the field.

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